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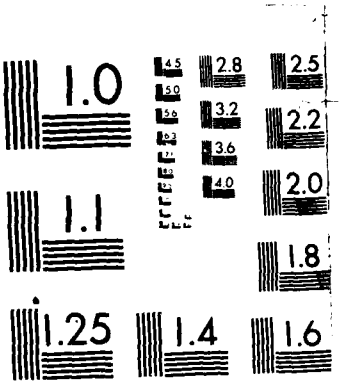

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

Report No. CG-D-3-86

AN EVALUATION OF THE INOGON LEADING MARK

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16. Abstract

This device

~~The Inogon Leading~~ Mark, a ~~single station range light~~, was evaluated in both a laboratory and field setting. In the laboratory evaluation, the detection range of the device was measured and accuracy with which one can use the device to navigate was established. In the field evaluation, the device was installed at Constable Hook Channel in New York Harbor immediately beneath the two station range, and user feedback was solicited in the form of a questionnaire. The device was shown to perform as described by the manufacturer, with detection ranges of approximately 1750 and 2250 yards in daylight and darkness, respectively. Responses from the field evaluation were generally negative, mostly because the device was perceived to have too short a detection range for the Constable Hook Channel. It is recommended that the device be considered as a candidate range light for very short range applications.

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METRIC CONVERSION FACTORS

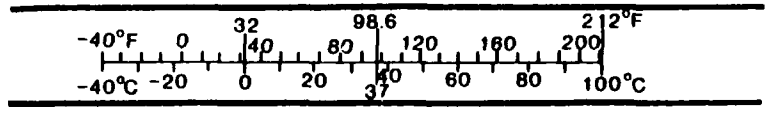
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
in	inches	* 2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (WEIGHT)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (EXACT)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures. Price $2.25. SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (WEIGHT)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	0.125	cups	c
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (EXACT)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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INTRODUCTION

This report describes the evaluation of the Inogon Leading Mark that was conducted by the Coast Guard Research and Development Center. The device is a single station range designed for short range applications. The Inogon device uses optical interference techniques to create, against a yellow background, a series of black chevrons (arrows) that point in the direction of the center of the channel. Figure 1 shows three views of the device. Figure 1a is a drawing of the face of the device when viewed from 9 degrees left of the centerline. Figure 1b is a drawing of the face of the device when viewed on centerline and Figure 1c shows the device being lowered into its temporary location at Constable Hook Channel in New York Harbor.

The Inogon Corporation markets several sizes of this device for different applications (Reference 1). The device that was evaluated was the LM-30. It is 11.5 feet high by 11 feet wide by 12.5 feet deep. Five 1000 watt and two 70 watt sodium vapor lamps provide the illumination. Two independently-adjusted daylight controls turn off lamps at twilight and nighttime to reduce the illumination. It is advertised (Reference 1) to have a nominal daytime range of 1800 yards and a nighttime range of 2200 yards.

Each device can be designed with a particular accuracy. The device that was evaluated was designed with an accuracy of 0.9 degrees. That is, the manufacturer claimed that within range of the device, one can detect when 0.9 degrees off center.

Initially the Inogon device was transported to the Research and Development Center (R&DC) for laboratory evaluation. At the R&DC, the device was mounted on a cart so that it could be rotated smoothly through 90 degrees. The detection range of the device was measured. Judgments as to when observers were on and off channel centerline, as well as judgments as to how far off channel centerline were made.

For the field evaluation, the device was placed in New York Harbor at Constable Hook Channel, directly beneath the two station range light. A questionnaire was used to solicit user responses as to the quality of information provided by the Inogon device.

METHODS

Laboratory Evaluation

To measure the detection range, a boat traveled out more than 3000 yards from the Inogon device and slowly approached it. The point at which at least 80% (4 of 5) of the observers could detect the presence of the stripes on the device with unaided viewing was considered to be the detection range. The distance was measured from radar position. The measurements were made in daylight and at nighttime.

To measure alignment accuracy, the Inogon device was placed on a movable platform that could be rotated around a pivot point centered under the front of the device while the observers remained in a fixed position. As the device was rotated, observers judged the angle of the device at which each observer

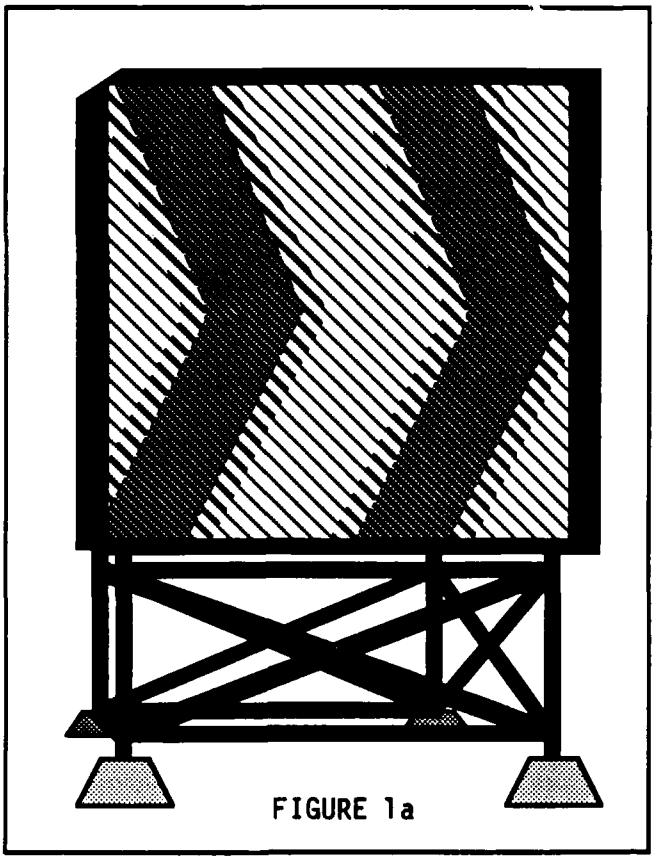

FIGURE 1a

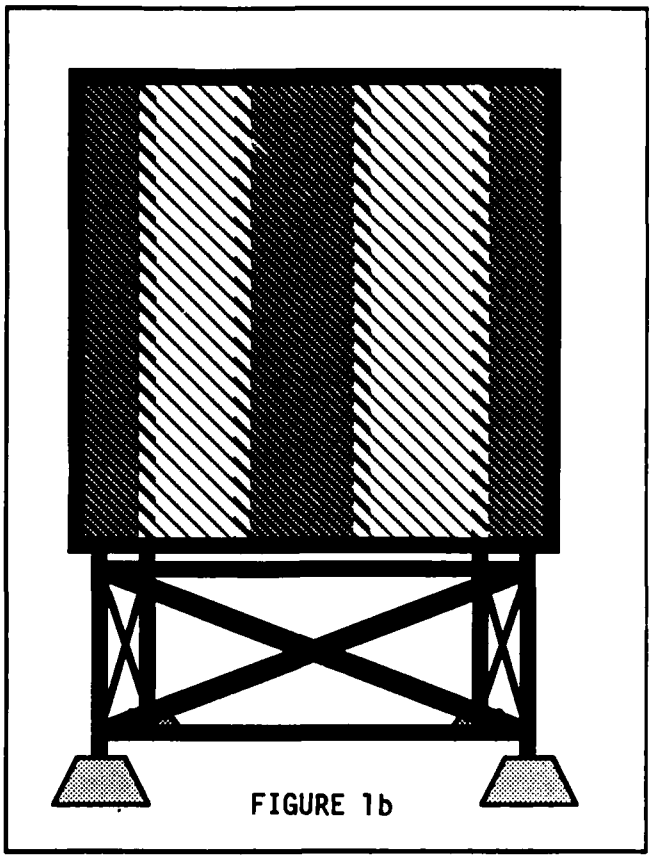

FIGURE 1b

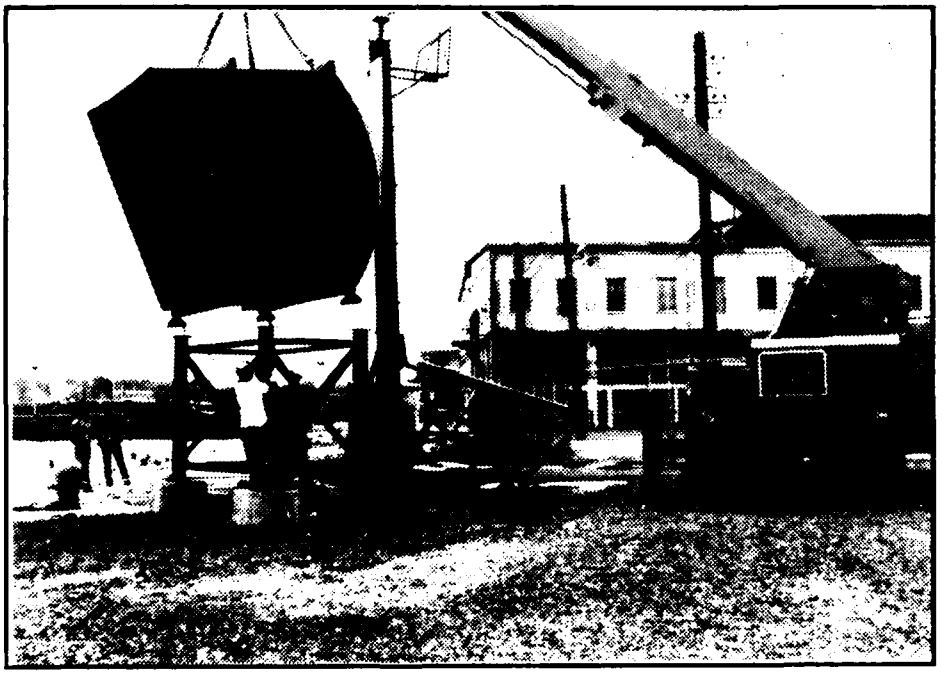

FIGURE 1c

FIGURE 1a - VIEW OF INOGON DEVICE WHEN 9 DEGREES LEFT TO CHANNEL CENTER
FIGURE 1b - VIEW OF INOGON DEVICE WHEN ON CHANNEL CENTERLINE
FIGURE 1c - TEMPORARY INSTALLATION OF DEVICE AT CONSTABLE HOOK CHANNEL, NEW YORK HARBOR

appeared on centerline and just discriminably off centerline. In addition, since the device provides off-axis information, observers judged two off-axis criterion points on either side of the centerline. They determined when the first black chevron appeared to touch the edge of the device (specified by manufacturer as being 9 degrees off center (Reference 2)) and the point at which the second black chevron touched the edge (specified by manufacturer as being 22.5 degrees off center). These measurements were repeated several times for four observers. Measurements were made with observers at two different distances (700 and 2100 yards) in daylight, twilight, and after dark.

Field Evaluation

The Constable Hook range was chosen for the field evaluation by mutual agreement between personnel at the R&DC, Third Coast Guard District's Office of Aids to Navigation, Coast Guard Headquarters Office of Short Range Aids to Navigation, Inogon Corporation, and the Sandy Hook Pilots Association. This range was selected for three reasons: (1) it is one of the most well-traveled ranges in the area, (2) it was possible to situate the device in a location directly below the current two station range so that direct comparisons could be made and (3) the range is defined on the charts (Reference 3) to be approximately 2200 yards, which is the maximum useful distance of the Inogon device (Reference 1). (The range lights are actually visible at distances beyond 3850 yards given the candlepower ratings (Reference 4), but the actual range, as shown on the chart, is 2200 yards (Reference 3)). Given these considerations, the device was placed at Constable Hook and energized on 11 July 1985. The device remained energized until 1 November 1985. Figure 2 is a partial chart of New York Harbor showing Constable Hook and the location of the device within the channel.

During the evaluation some pilots commented that the device was difficult to visually acquire during the day, and that at night, the sodium vapor lamps on Exxon property interfered with the device. In August, a flashing beacon was placed on top of the device to improve the daytime acquisition distance, and Exxon voluntarily placed baffles on the offending sodium vapor lamps.

A questionnaire was published in the Local Notice to Mariners and distributed to the pilot groups to solicit responses from the users of the device. The questionnaire is duplicated as Appendix A.

RESULTS

Detection Range

The detection range proved to be dependent on the observers' position. It was greatest when at or near the centerline, but when a few degrees off the centerline, the chevron pattern could not be resolved until the observers moved closer to the device. The detection range in daytime was found to be approximately 2000 yards when on channel center and approximately 1750 yards when 9 degrees off channel center. This daytime range estimate is quite sensitive to the location of the sun relative to the device and the background near the device. At night, the detection range when on the centerline was approximately 2500 yards and about 2250 yards at 9 degrees off the centerline.

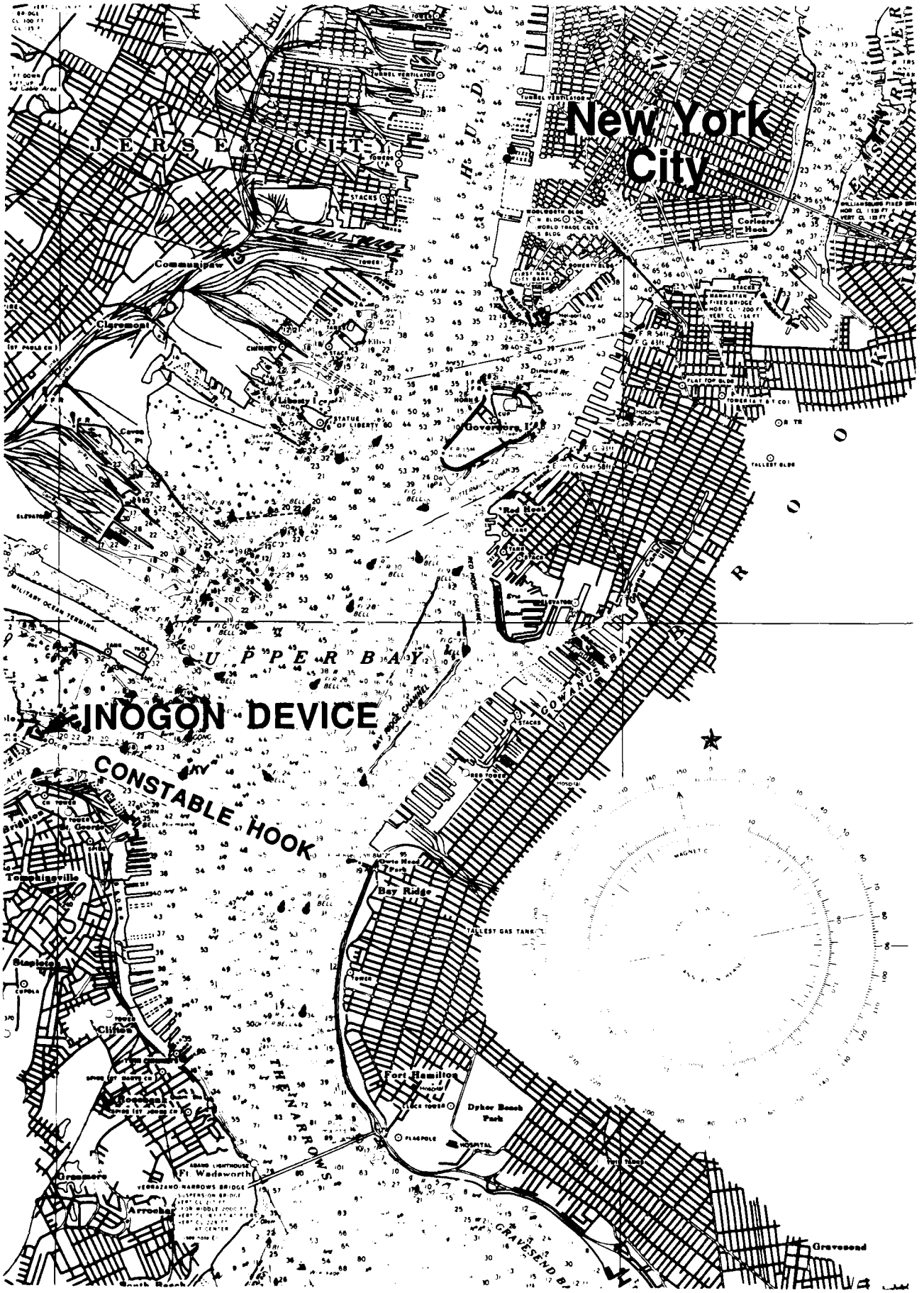

FIGURE 2 - CHART SHOWING CONSTABLE HOOK CHANNEL AND LOCATION OF INOGON DEVICE WITHIN CHANNEL

These differences in detection range with angular position result from known properties of the human visual system. As the number of stripes per degree of visual angle (spatial frequency) increases beyond two or three, the ability to detect the stripes decreases (Reference 5). Also, the ability to detect stripes is decreased when they are tilted from vertical (Reference 6). With the *Inogon* device, as one moves off the center of the channel, the spatial frequency of the stripes increases and the stripes tilt. For these two reasons detection range is reduced when off-center.

Alignment Accuracy

Figure 3 shows the mean angular deviations of four observers in judging the different position criteria described in Methods. The device was designed so that: a) off center can be detected at an angle of 0.9 degrees; b) the first black chevron touched the edge of the device at 9.0 degree; and c) that the second black chevron touched the edge at 22.5 degrees. The symbols plot the mean deviation of the observer judgments from these advertised values. For the "on center" criterion, the data represent the deviation from true 0.0 degrees. The vertical bars are plus and minus 1.0 standard deviation.

Figure 3a shows daytime data with unaided viewing. The squares are for the judgments at a distance of 700 yards and the circles at a distance of 2100 yards. At 2100 yards, observers could make on- and off- center judgments but had difficulty with the other criteria, as they could not resolve the lines. These measurements were repeated at 2100 yards with binoculars, as shown in Figure 3b.

Figure 3c shows the mean angular judgments made at twilight and nighttime from 700 and 2100 yards. These data were combined for clarity, as there was no effect of time of day or distance on angular position judgments.

Observers had little difficulty in judging the centerline of the device. In judging off center, observers tended to require larger angles than the 0.9 degrees that was advertised. When the criterion was to judge when the first and second black chevrons touched the edge of the device, observers tended to underestimate the angle.

Field Evaluation

Fifty-four individuals responded to the questionnaire that was distributed. Thirty-one responses were from pilots, most from the Sandy Hook Pilot's Association, seventeen were from tug boat operators, and six were from other boat operators and pleasure boaters. The respondents were asked to compare the Inogon device to the current two station range using a number of different criteria. A response of "1" means that the Inogon device was judged to be much poorer than the two-station range, a value of "4" means that the two ranges were judged to be equal, and a value of "7" means that the Inogon device was judged to be far superior to the two-station range. Table 1 summarizes the responses to some of the questions given by the respondents. Data are shown for comparisons of the ability to locate the Inogon device in daylight, twilight and nighttime (Question 4 (Q4)), the positional (Q5) and directional (Q6) sensitivities of the device, the rate-of-motion information

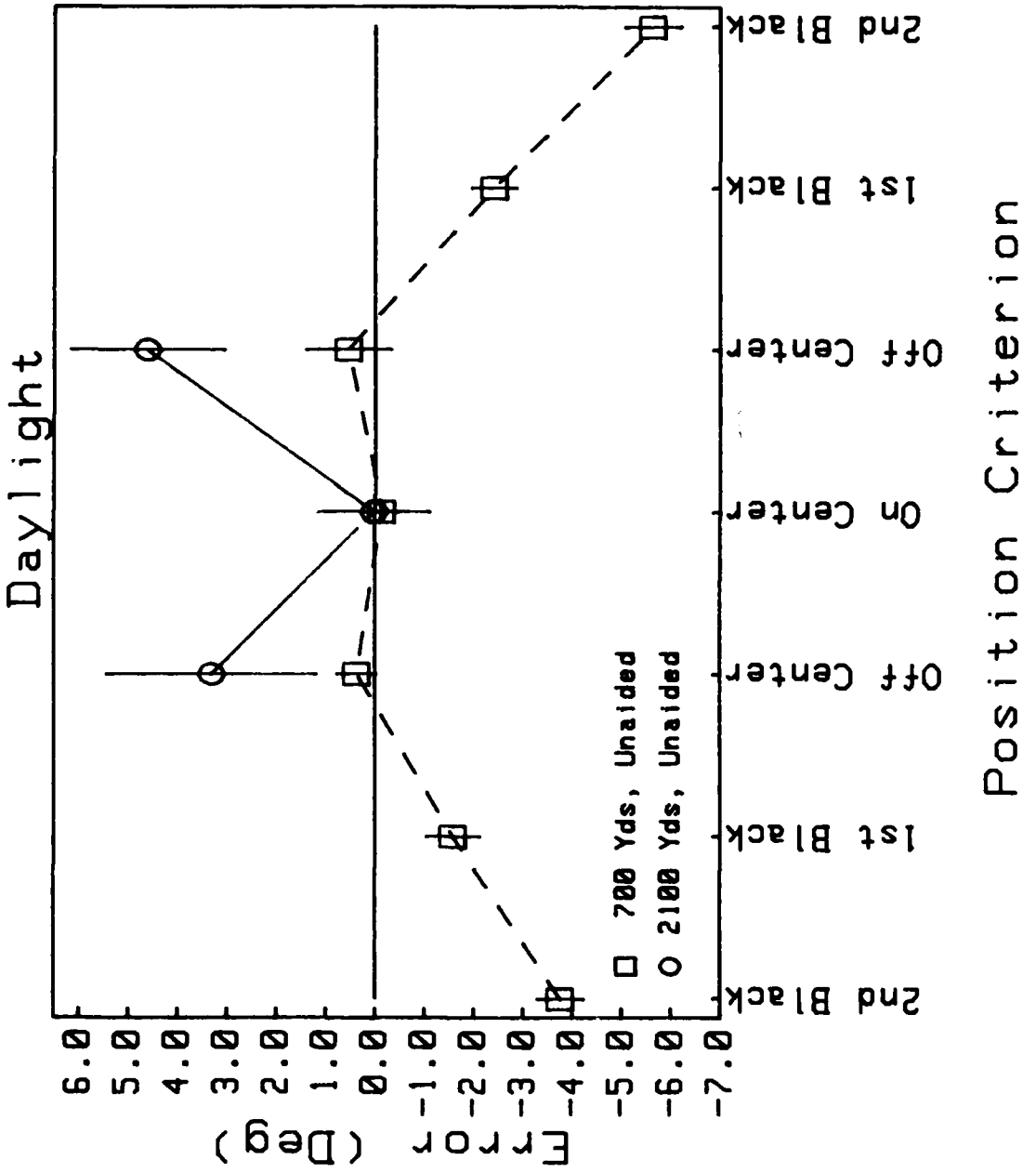

FIGURE 3a - MEAN DEVIATION OF OBSERVER JUDGMENTS FROM ADVERTISED VALUES FOR SEVEN POSITION CRITERIA. DAYTIME VIEWING WITHOUT BINOCULARS.

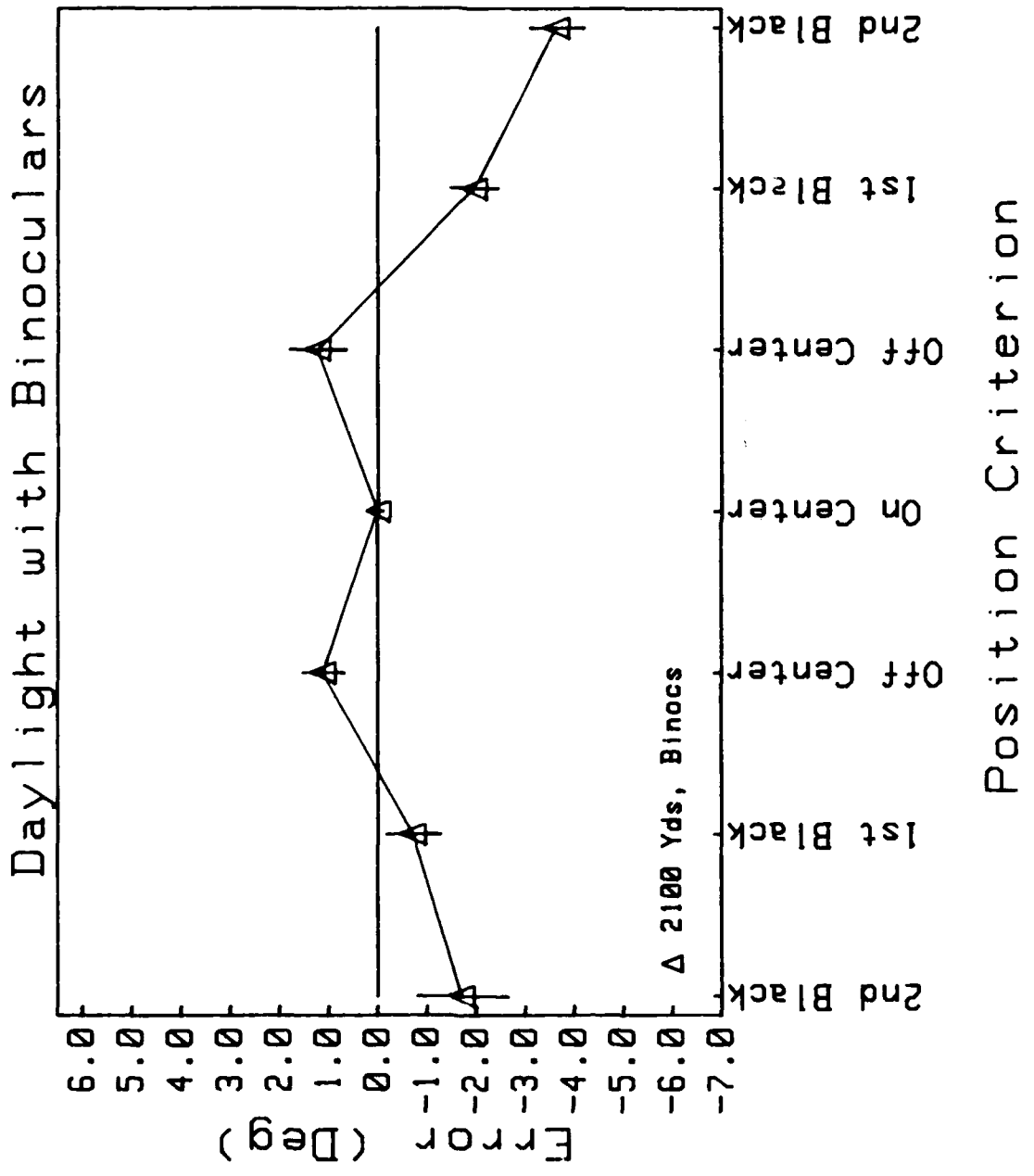

FIGURE 3b - MEAN DEVIATION OF OBSERVER JUDGMENTS FROM ADVERTISED VALUES FOR SEVEN POSITION CRITERIA. DAYTIME VIEWING WITH BINOCULARS.

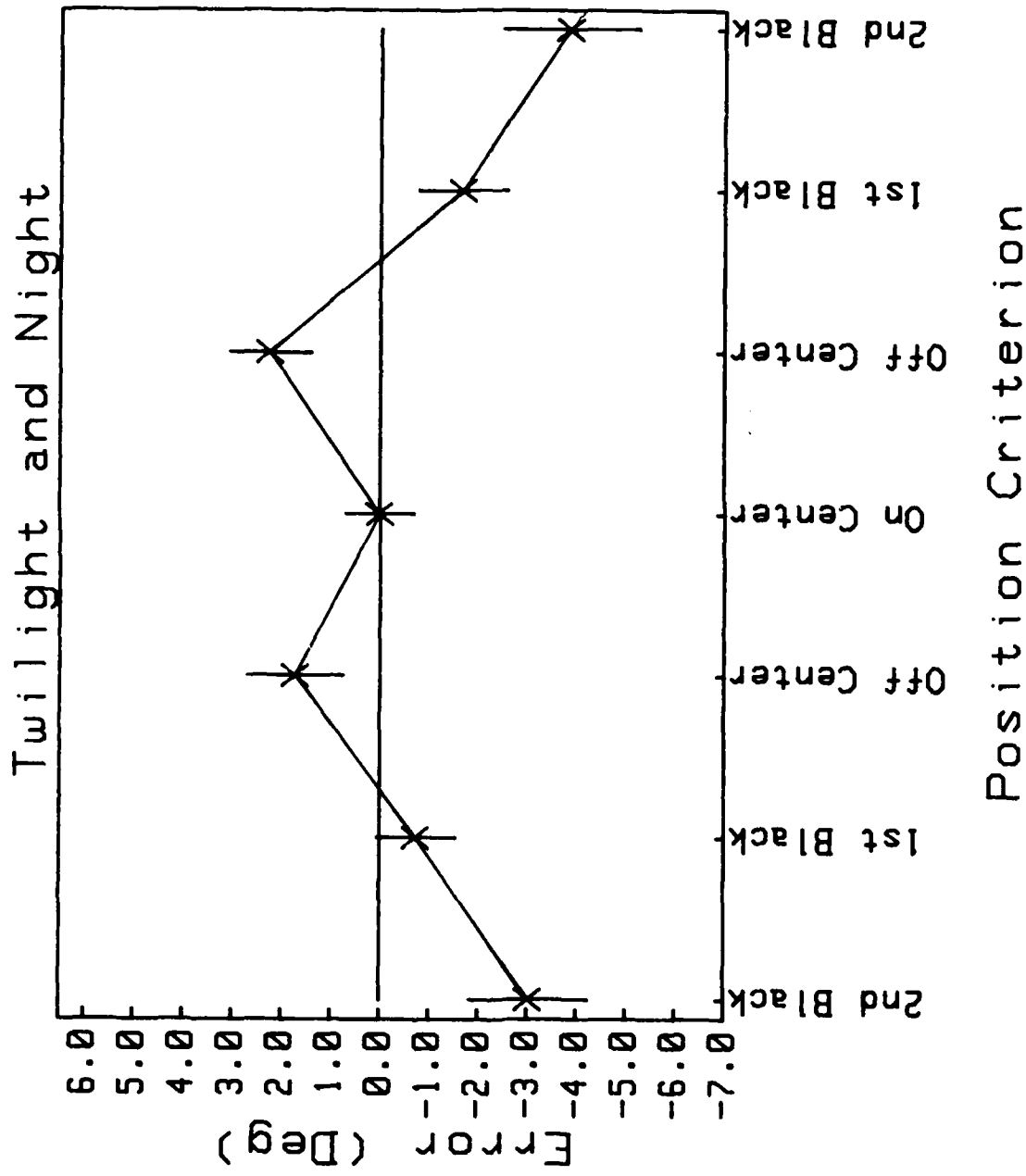

FIGURE 3c - MEAN DEVIATION OF OBSERVER JUDGMENTS FROM ADVERTISED VALUES FOR SEVEN POSITION CRITERIA. TWILIGHT AND NIGHTTIME VIEWING.

TABLE I

PILOTS

Response	Q4 Locate Day	Q4 Locate Twi	Q4 Locate Nite	Q5 Position Sensitivity	Q6 Direction Sensitivity	Q7 Rate of Motion	Q8 Overall Quality	Q11 Permanent ?
1	2	2	4	2	2	2	2	No
2	1	2	2	5	6	5	3	Yes
3	1	1	1	4	7	7	1	No
4	7	6	5	7	6	6	6	Yes
5	4	5	5	5	4	4	4	No
6	1	1	1	1	1	1	1	No
7	5	3	3	5	5	5	3	Yes
8	2	1	3	2	4	3	2	No
9	3	3	5	5	5	5	5	Yes
10	1	1	1	1	1	1	1	No
11	1	1	1	1	1	1	1	No
12	1	1	1	2	2	2	1	No
13	3	3	3	3	5	5	4	Yes
14	2	2	-	7	7	7	1	No
15	2	1	1	3	4	3	2	Yes
16	2	2	-	2	4	1	2	No
17	5	5	5	1	1	1	1	No
18	1	1	1	1	1	1	1	No
19	2	2	3	2	3	3	2	No
20	3	2	1	2	2	-	1	No
21	1	1	1	-	7	7	1	No
22	1	1	1	1	1	1	1	No
23	1	1	1	1	1	1	1	No
24	-	-	1	1	1	1	1	No
25	1	1	1	4	3	4	1	No
26	1	1	1	1	1	1	1	No
27	5	6	6	5	6	4	4	No
28	3	5	2	2	4	3	3	No
29	3	3	3	2	3	3	2	Yes
30	1	1	1	4	3	5	1	Yes
31	3	3	4	4	3	1	2	No
Number of Responses:								
31	30	30	29	30	31	30	31	31
Average:	2.3	2.3	2.3	2.9	3.4	3.1	2.0	26% Yes

TABLE I (continued)

TUG OPERATORS

Response	Q4 Locate Day	Q4 Locate Twi	Q4 Locate Nite	Q5 Position Sensitivity	Q6 Direction Sensitivity	Q7 Rate of Motion	Q8 Overall Quality	Q11 Permanent ?
1	3	3	3	2	1	2	2	No
2	1	1	1	4	4	4	1	No
3	3	3	2	1	1	2	2	No
4	1	3	3	6	6	6	6	Yes
5	-	-	6	3	6	7	6	Yes
6	4	4	4	1	1	1	1	No
7	2	2	2	4	7	7	3	No
8	7	7	7	7	7	7	7	Yes
9	1	1	1	1	1	1	1	No
10	7	7	7	7	7	4	7	Yes
11	7	7	7	7	7	7	7	Yes
12	1	1	1	1	1	1	1	No
13	7	6	6	7	7	7	7	Yes
14	4	4	1	5	4	6	6	Yes
15	2	2	1	3	2	2	1	No
16	2	4	4	3	3	3	2	No
17	3	4	2	2	3	2	2	No
Number of Responses: 17	16	16	17	17	17	17	17	17
Average:	3.4	3.7	3.4	3.8	4.0	4.1	3.6	41% Yes

TABLE I (continued)

OTHERS

Response	Q4 Locate Day	Q4 Locate Twi	Q4 Locate Nite	Q5 Position Sensitivity	Q6 Direction Sensitivity	Q7 Rate of Motion	Q8 Overall Quality	Q11 Permanent ?
1	-	5	-	2	2	2	2	No
2	-	4	-	6	4	4	5	No
3	3	5	7	5	7	5	7	Yes
4	7	7	-	7	7	7	7	Yes
5	6	-	-	4	5	5	6	Yes
6	5	7	7	6	7	7	7	Yes
Number of Responses:	6	4	5	2	6	6	6	6
Average:		5.2	5.6	7.0	5.0	5.3	5.0	5.7	67% Yes

GROUP DATA

Number of Responses:	54	50	51	48	53	54	53	54	54
Average:		2.9	3.0	2.9	3.4	3.8	3.7	2.9	35% Yes

(Q7), the overall quality (Q8), and whether or not the device should remain at Constable Hook (Q11). Answers to the questions about the useful distance (Q9) and the detection range (Q10) are not shown, since many of the answers were ambiguous. In more than fifty percent of the cases it was not possible to assign a precise distance from the answer provided. Responses to questions on the importance of off-axis information (Q13), the virtues and weaknesses of the Inogon device (Q14), and the requested improvements in the two station range (Q15) are provided in the text below. (Specific questions can be found in the Appendix.)

On average, the device was judged to perform less well than the two-station range. It can be seen that the pilots, as a group, were most critical of the device, reporting that it performed more poorly than the parallax range in all respects. The tug operators were less critical, and the group labeled "Others" judged the device to be better than the parallax range. The respondents, as a group, were opposed to keeping the device at Constable Hook.

In terms of the useful distance and the visibility range (Q9, Q10), most felt that the device was visible within the "KV" buoy, but many commented that the useful range should be much greater than the distance of the "KV" buoy (Position of "KV" buoy is noted in Figure 2. Distance is approximately 2200 yards from the Inogon device). In terms of off-axis information (Q13), the pilots as a group did not believe such information was necessary, while the tug operators preferred the additional off-axis information.

Of those respondents who were favorable toward the device, its greatest virtues were reported to be the off-axis information and ease with which it could be used to judge position. Overwhelmingly, the main weakness was perceived to be the short detection range.

For improvements in the current two station range, most of the respondents felt that the background should be masked and that the acquisition distance should be increased. Eight respondents commented that the range lights should be elevated more.

Other Considerations

In spite of the size of the device, installation is relatively simple. Access to the lamps and power distribution panel is through a door cut in the frame. The actual power connection was straightforward and well-documented. The lamps are directly accessible and the alignment could be accomplished by eye.

The face of the device is made of large plexiglass sheets with black lines painted on them. After transporting the device from Connecticut to New Jersey, many of the screws that hold the plexiglass had fallen out and had to be replaced. The plexiglass sheets had shifted slightly and required realigning. This alignment was sophisticated, but should not usually be required.

DISCUSSION

The Inogon Leading Mark Model LM30 has been shown to provide the visibility range advertised by the Inogon Corporation. The advertised accuracy of the device of 0.9 degrees, which is the angle at which a deviation from the centerline can be detected, was smaller than what was observed. Observers required between 1.4 and 2.2 degrees of deviation before they believed they were no longer on channel center. This accuracy varied with viewing condition, being closest to the advertised value in daylight at 700 yards. This variation in accuracy is not viewed as a problem, as the accuracy of the device can be redesigned to suit the channel.

Once off the centerline, observers tended to believe they were farther off centerline than they actually were. While the first black chevron physically touches the edge of the device at 9.0 degrees, observers believed this point was reached between 7.0 and 9.0 degrees. Observers believed the second black chevron touched the edge of the device between 16.0 and 22.0 degrees, rather than the actual angle of 22.5 degrees. That these deviations occur and that they are smallest in daylight at short distances is expected given the data on visual resolution (Reference 7). The task facing the observers is one of determining when the tip of the chevron is just touching the edge of the device. Visual resolution improves with background luminance, thus observers should be better able to resolve the tip of the chevron in daytime. Furthermore resolution is a function of the spatial frequency of the pattern. As distance increases, spatial frequency increases and resolution decreases.

It is believed that the negative responses that resulted from the field evaluation reflect the inappropriateness of the Constable Hook range as the evaluation site for the device. Respondents were asked to judge the performance of the device when within the "KV" buoy but it is clear from many of the comments that there were expectations that the device would be visible from well outside the "KV" buoy. The main comment given was that the Inogon device was not visible at the distances that were required in the Constable Hook Channel. Pilots stated that they typically begin using the parallax range when they are as far as 4 miles out; a distance that is well beyond the range of the Inogon device when viewed with the naked eye. When within the range of the device, which means within the "KV" buoy, the pilots stated that the range was no longer necessary for navigation. It is this issue of distance of visibility that seems to have had an extremely negative effect on the opinions of those mariners who used the range. Perhaps, had a different location been chosen, one where the range light is truly only used within a distance of 1 mile, responses may have been much more positive.

Certainly the main limitation of the Inogon system is that it is only for very short range applications. The laboratory data demonstrated that observers can easily and reliably use the information provided by the range light to gauge their position within a channel. Not only does one have information as to whether or not they are on centerline, there is usable off-axis information. This off-axis information can be unambiguously communicated, such as, when the black chevron touches the edge, one is 9 degrees off the channel. In a parallax range, this information is ambiguous, as the horizontal angular separation between the lights is a function of the distance from the lights, as well as the sensitivity (K factor) of the range.

CONCLUSIONS AND RECOMMENDATIONS

- The Inogon LM30 Leading Mark performs essentially as advertised by the manufacturer. The LM30 should not be used in applications where a visible range of more than 2000 yards is required. Within its advertised range the device performs as described by the manufacturer.

- The LM30 consumes between 140 and 5140 watts depending on the mode of operation (night/day).

- The device functioning as a single station range provides off-axis information without the need of a second, higher rear tower.

- The Inogon Leading Mark is an aid to navigation appropriate for use in applications up to 2000 yards. The device should be considered in applications where precise alignment of a vessel is necessary, and the installation of a standard range, as defined in COMDINST M16500.7, paragraph 4.C.2, (Reference 8) is not possible. Like the Direction Light defined in COMDINST M16500.7, paragraph 4.E.2.f.(2).(c) (Reference 8), the Inogon device is an alternative tool for marking a waterway where standard range construction is not possible. The cross-track information of the Inogon device is superior to that of Direction Lights in that the Inogon device provides continuous cross-track information.

REFERENCES

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APPENDIX A

QUESTIONNAIRE ON PERFORMANCE OF DEMONSTRATION RANGE LIGHT AT CONSTABLE HOOK, NJ

QUESTIONNAIRE ON PERFORMANCE OF DEMONSTRATION
RANGE LIGHT AT CONSTABLE HOOK, NJ

The demonstration single station range light at Constable Hook, NJ has been installed at a number of foreign locations, however it is the first of its kind in the United States. The Coast Guard Research and Development Center, which is responsible for this demonstration of the range system, is collecting data on the performance characteristics of this device. Feedback from those who have used this range is helpful in this evaluation. Answers to the following questions will assist in our evaluation of this device. Feel free to write comments anywhere on this questionnaire. The questionnaire should be mailed to Dr. Marc Mandler, U.S. Coast Guard Research and Development, Avery Point, Groton, CT 06340-6096.

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1. How many times have you used the demonstration range light at Constable Hook?

1 2 3 4 5 more than 5

2. In what kinds of weather conditions have you used the range?

Clear Haze Fog Rain Other (specify)

3. At what times of day have you used the demonstration range?

Daytime Twilight Nighttime

4. Realizing that the demonstration range is designed for short range applications only, once you are positioned within the "KV" buoy, how would you rate your ABILITY TO VISUALLY LOCATE the demonstration single station range as compared to the two station range?

	1	2	3	4	5	6	7
DAYTIME	much poorer			about same			much better
TWILIGHT	much poorer			about same			much better
NIGHTTIME	much poorer			about same			much better

5. Once positioned within the "KV" buoy, how would you rate the POSITION SENSITIVITY of the demonstration range as compared to the two station range? In other words, how well can you determine WHERE you are in the channel using this device, compared to the two station range?

1	2	3	4	5	6	7
much poorer			about same			much better

6. Once positioned within the "KV" buoy, how would you rate the DIRECTIONAL SENSITIVITY of the demonstration range relative to the two station range? That is, how well can you tell your DIRECTION OF MOTION across the channel?

1	2	3	4	5	6	7
much poorer			about same			much better

7. Once positioned within the "KV" buoy, how would you rate your ability to judge your RATE OF MOTION across the channel for the demonstration range relative to the conventional range?

1	2	3	4	5	6	7
much poorer			about same			much better

8. How would you rate the OVERALL QUALITY of the demonstration range as compared to the two station range?

1	2	3	4	5	6	7
much poorer			about same			much better

9. At what distances from the demonstration range light did you find it most useful as an aid to navigation?

10. With unaided viewing, at what distances did the chevron pattern become visible in daytime?

Nighttime?

11. Do you feel that this demonstration range should become permanent at Constable Hook Channel?

YES NO

12. If you answered "YES" to the question above, is your answer still "YES" if the demonstration range is the sole range light in the channel?

YES NO

13. The demonstration range provides off-axis information in a wider sector than that provided by the two station range. Is this additional off-axis information necessary in lining up the range?

YES NO

14. What do you believe to be the greatest virtue (strength) of this demonstration range light?

What is its main weakness?

15. If the demonstration range light is removed, what improvements do you think should be made to the current two station range light?

a. Improve off-axis performance
b. Improve acquisition distance.
c. Change color or characteristic.
d. Mask background.
e. Eliminate the range light.

16. User Information:

a. Sandy Hook Pilot
b. Tug boat operator
c. Pleasure boater
c. Other (specify)

END

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